

## SECTION III.—FORECASTS.

## FORECASTS AND WARNINGS FOR MARCH, 1918.

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## GENERAL PRESSURE DISTRIBUTION OVER THE NORTHERN HEMISPHERE EXCEPT EUROPE AND INTERIOR ASIA.

Over the Pacific Ocean, as indicated by the observations at Midway Island and Honolulu, pressure was generally low after the first few days of the month. After the 24th reports were incomplete.

Over the Aleutian Islands high pressure ruled throughout the month except from the 25th to the 27th, inclusive, when it was moderately low. From the 7th to the 9th, inclusive, the pressure was abnormally high, with a crest of 30.98 inches on the 7th.

The Aleutian high pressures also extended in virtually the same marked form over Alaska during the first decade of the month, but thereafter pressure over Alaska was generally low, except between the 19th and 24th, when it was moderately high over northern Alaska. There was, however, but one period of pronounced depression, the 12th and 13th, with a minimum of 28.70 inches at Valdez on the 13th.

Over the United States proper conditions were not unusual for the month of March. During the first two decades there was a fairly uniform alternation of high and low pressure periods, each of two or three days duration, with three quite marked cyclones and one anticyclone, the latter that of the 15th. During the third decade of the month pressure was generally, although not decidedly, low, especially from the Ohio Valley eastward and southward.

Over the northern portion of the western Atlantic Ocean low pressure prevailed almost uniformly, with a minimum of 28.84 inches at Saint John's, N. F., on the 16th. Over the central and southern portions pressure was higher, Bermuda and Turks Island ruling moderately high until after the 20th when there was a reaction to moderate subnormal conditions.

## STORM WARNINGS.

On the morning of the 2d there was a moderate disturbance over northern Lake Superior. It moved rapidly eastward during the next 24 hours, with considerable increase in intensity attended by gales throughout the Lakes region, New York, and New England. As the development of the storm was not of marked character until after it reached New England, the only strong winds were those from the northwest, and, as they could continue for only a few hours, no storm warnings were ordered. The highest wind velocity reached was 72 miles an hour from the northwest at New York City during the night of March 2-3.

On the morning of the 5th pressure was low over the Central Plains States and the upper Mississippi Valley, with a cold high area to the northwestward. By the night of the 5th the disturbance was central over Illinois, and a warning of strong northerly winds, with snow and much colder weather, was sent to open ports on Lake

Michigan. Cold winds, with some local snows, followed, but the winds were no more than fresh. The disturbance drifted slowly eastward to New England; on the morning of the 7th there was a redevelopment off the Virginia coast, and, accordingly, northeast storm warnings were ordered on the New England coast from Block Island, R. I., to Provincetown, Mass., and on the eastern Maine coast, for strong northeast to north winds that would diminish by the following morning. Some northerly strong winds occurred during the afternoon of the 7th on the southern New England coast, but the disturbance rapidly disintegrated, and the warnings were lowered at 9 p. m.

In the meantime another disturbance of marked character had moved in by way of the northern California coast, and by the night of the 8th it was central over eastern Colorado, with a strong gradient to the northeastward. Advisory messages were then sent to the open ports on Lake Michigan for strong northeast winds, with snow on the following day. On the morning of the 9th the storm was central over extreme eastern Nebraska with a barometer reading of 29.10 inches at Lincoln, and strong easterly winds, with snow, prevailed on Lake Michigan. The warnings were repeated on the evening of the 9th, at which time snow continued on Lake Michigan, with northeasterly to northerly gales, that reached a velocity of 60 miles an hour at Green Bay, Wis. At 5 p. m. on the same day southwest warnings were ordered on the Atlantic coast from Eastport, Me., to Southport, N. C., for south winds shifting to southwest and reaching gale force on the following day. The winds occurred as forecast, so far as velocity was concerned, but not as to direction on the New England coast; and on the morning of the 10th, with the storm central over Long Island, the warnings were changed to northwest and extended southward to Jacksonville, Fla. During the day, northwest gales occurred quite generally, with a maximum velocity of 84 miles an hour at New York City, and of 60 miles an hour at Norfolk, Va.

Another storm from the North Pacific reached eastern Lake Superior by the morning of the 12th, and at 11 a. m. southwest warnings were ordered from Delaware Breakwater, Del., to Eastport, Me., for strong southwest winds, shifting to west and northwest on the following day. These warnings were not generally justified owing to the rapid approach of another disturbance from the west, although a velocity of 44 miles an hour was reached at Nantucket, Mass.

On the morning of the 13th, the second western disturbance just referred to was central over northern Kansas, and advisory messages were sent to open ports on Lake Michigan for strong northeast to north winds, with snow or rain. These conditions occurred as forecast, although the winds were only moderately strong.

On the morning of the 14th the disturbance was central over northern Ohio, and at 2:30 p. m., after a special observation had been received, southwest warnings were ordered on the Atlantic coast from Southport, N. C., to Baltimore, Md., and southeast warnings from Delaware Breakwater, Del., to Eastport, Me., winds to shift to west and northwest by the following morning. Only

moderately strong winds occurred in advance of the storm center; but on the 15th, when it was over Nova Scotia, the warnings were changed to northwest, and northwest gales occurred during the day. By the night of the 15th conditions had become more moderate, and the warnings were lowered at 9 p. m.

On the morning of the 15th another disturbance was central over southwestern Alaska; during the next 48 hours it moved to northwestern Ontario in quite marked form, and at 2:30 p. m. southwest warnings were ordered on the Atlantic coast from Sandy Hook, N. J., to Eastport, Me. Strong southwest winds occurred as forecast, with a maximum velocity of 60 miles an hour, from the west at New York City. The wind subsided rapidly after 8 p. m. of March 17, and on the following morning the warnings were lowered.

There were no further warnings during the month.

#### COLD WAVE AND FROST WARNINGS.

There was a rapid rise in pressure over the northern portion of the country following the storm of March 2-3; and on the morning of March 4 there was a moderate cold wave in northern New England, for which no warnings had been issued.

A cold wave from the northwest followed the Plains States' disturbance of the 4th and 5th, and on the morning of the 5th cold-wave warnings were ordered for upper Michigan. At night and the following morning they were ordered for southern lower Michigan, northern Indiana, and northern Ohio. A decided fall in temperature followed, and the warnings were verified as a whole.

Following a severe disturbance that was over eastern Nebraska on the morning of March 9, cold-wave warnings were ordered for Kentucky, Tennessee, north Michigan, southern Ohio, and western West Virginia. A decided fall in temperature followed, amounting to as much as 44 degrees in 24 hours in the upper Ohio valley; and the warnings were generally verified.

On the morning of the 10th, with a storm central over northern Ohio, cold-wave warnings were ordered for the Middle Atlantic States, western New England, the interior of the southern Atlantic and eastern Gulf States; and frost warnings for northern Florida and along the eastern Gulf coast. These warnings were verified in nearly all localities, except in the extreme South, where there was no frost.

On the morning of the 15th marked high pressure prevailed over the greater portion of the country, with a crest of 30.72 inches over South Dakota; and frost warnings were sent to eastern North Carolina, the interior of northern and central South Carolina, and the northern portions of Georgia, Alabama, and Mississippi, with a possibility of extension into the central portions of the three last-named States. Cloudy weather intervened, however, during the night, and there were no frosts south of Tennessee and North Carolina.

On the morning of the 17th, with high pressure and low temperature over eastern Texas, frost warnings were ordered for interior Mississippi; but again cloudy weather intervened, although freezing temperature was reported at Corinth, in the extreme northern portion of the State, and frost occurred in Tennessee and western North Carolina.

There were no further frost warnings until the morning of the 25th, when pressure was moderately high over the lower Missouri Valley, and low off the North Carolina coast. Frost warnings were ordered for Tennessee and the northern portions of the South Atlantic and East

Gulf districts. These warnings were verified, except in Mississippi and Alabama.

Local frosts occurred in southern Virginia and North Carolina on the 29th, 30th, and 31st, although no warnings were sent, except on the 29th. The frosts were of little consequence.

#### SPECIAL WARNINGS.

On the morning of the 9th, with the previously mentioned severe disturbance over eastern Nebraska and high pressure to the northeastward, heavy snow warnings were ordered for upper Michigan and northern lower Michigan. Heavy snow occurred as forecast and extended eastward to northern New England, while over southern lower Michigan there was a considerable quantity of snow and ice.

The Chief Hydrographer of the Panama Canal reported a norther on the 11th and 12th. At Colon the wind reached a velocity of 30 miles an hour from the east on both days, while at Balboa Heights the maximum velocity was 35 miles an hour from the north on the 12th. This norther was not forecast, as precedent conditions were somewhat doubtful. No damage was done.

A warning of strong northerly winds was sent on the 15th, when a great cyclone on the North Atlantic coast was followed by an equally great anticyclone, with a strong gradient between. The anticyclone, however, materially changed its formation during the ensuing 24 hours, and no winds of consequence occurred in the Canal Zone.

#### WARNINGS FROM OTHER DISTRICTS.

*Chicago, Ill., forecast district*—The special advices issued in the Chicago forecast district in the month of March were confined to cold-wave and cattle warnings during the first decade.

On the evening of the 3d a cold wave appeared in the British Northwest, with an extensive low-pressure area in the sections lying to the south, and cold-wave and cattle warnings were issued on the following day to northwestern districts and extended on the 4th and 5th southward over the middle Plains States and eastward over the upper Mississippi valley and western Lakes region. Advices of conditions dangerous to cattle were issued at the same time to stockmen in Montana, Wyoming, South Dakota, Nebraska, and Kansas. The cold wave pushed southward, losing steadily in energy, and by the evening of the 6th the temperature had begun to moderate rapidly in the Northwest.

Cattle warnings were again issued on the morning of the 8th to Montana, Wyoming, South Dakota, and western Nebraska, in advance of another storm which was approaching from the Plateau region and moving directly eastward over the middle States with increasing intensity; and on the 9th heavy snow warnings were sent to eastern Minnesota and western and northern Wisconsin points.

The various advices were justified for the most part, although the cold-wave warnings in the eastern portion of the district failed of technical verification. It is not known, however, what benefits were directly due to the warnings.

No other warnings were issued during the balance of the month, the period lying between the cold wave and frost warning seasons. One rather severe storm, accompanied by extensive precipitation and strong shifting winds, passed eastward of the central portion of the district at the close of the second week, and two disturbances later skirted the western and southern portions of the district; otherwise, the weather was uneventful.—*H. J. Cox, District Forecaster.*

*Denver forecast district.*—Although several low-pressure areas of considerable depth moved eastward across the district, no severe weather followed in the wake of the depressions. Low temperatures were of short duration; in fact, the month was marked by a persistency of temperatures much above the seasonal average.

On the morning of the 4th low pressure prevailed from southern Nevada northeastward to Minnesota, with the greatest barometric depression in northern Wyoming. During the next 24 hours the front of the high pressure that was developing in the distant north moved southward to northeastern Wyoming, while the long axis of the low moved a corresponding distance southward. Cold-wave and live-stock warnings for eastern Colorado were issued on the 4th and repeated on the morning of the 5th. Further progress of the anticyclone southward was slow, and while sharp falls occurred in eastern Colorado no very low temperatures were reached. Several other depressions of marked energy moved eastward across the district, but no other cold-wave and live-stock warnings were issued or needed.—*Fredk. H. Brandenburg, District Forecaster.*

*New Orleans, La., forecast district.*—Storm warnings were not needed and no storm warnings were issued. However, on the 8th and 13th, for brief periods near the time of highest daily temperature, southeast winds exceeding the verifying velocity occurred at Corpus Christi. The cyclonic areas in these instances were central far inland and without marked barometric gradients in southern Texas.

The weather was free from severe cold waves; and temperatures, for the most part, were mild for the season, furthering early development of vegetation and necessitating frost warnings earlier than is usual in the northern portion of the district. By the close of the month these warnings were called for practically throughout the district.

On the 4th a depression of considerable extent, but moderate intensity, extended from the Lakes Region to the central Rocky Mountain States; and a moderate high was moving southward. A cold-wave warning was issued the night of the 4th for the Texas Panhandle and was extended the next morning over Oklahoma. The warning was verified over a considerable portion of Oklahoma. A considerable drop in temperature occurred in the Texas Panhandle, but not as great as was expected, due to continued low pressure over the southern Plateau States and weakening of the high.

With a deep low over extreme eastern Nebraska and a high over central Canada, cold-wave warnings were issued on the morning of the 9th for Oklahoma and northwestern Arkansas and were verified.

As mild weather had preceded the cold waves of the 5th-6th and the 10th, stockmen in the affected areas were given timely warning of the sudden changes that occurred.

Warnings issued for freezing temperature and frosts were mainly for areas in the northern portion of the district and were mostly verified. Such warnings were issued on the 1st, 4th, 6th, 9th, 10th, 14th, 15th, 16th, 21st, 22d, 23d, 24th, 28th, 29th, and 30th. On the 17th frost occurred in northwestern Louisiana, of which warning was given. The freeze in the Texas Panhandle and portions of Oklahoma on the 6th was predicated 48 hours in advance.

Fire-weather warnings were issued for the forested areas of Oklahoma on the 5th, 8th, 11th, 13th, and 18th,

and of Arkansas on the 11th, 13th and 28th. Conditions occurred as forecast except that the wind velocity did not increase on the 19th, due to diminishing intensity of the northwestern low on which the warning was based. On the 13th fair weather was successfully predicted for the following "three or four days" in the messages sent to the forest supervisors.—*R. A. Dyke, Assistant Forecaster.*

*San Francisco, Cal., forecast district.*—March, 1918, like the preceding month, was one of generous rainfall and seasonable temperature. The weather was not unusually stormy for the season and there was no interruption of transportation. Rain continued with but little interruption in Washington and more than the average frequency in other sections of this district, but no excessive daily amounts were reported. There were three well-marked rainy periods in California, from the 6th to the 8th, inclusive, 11th and 12th, and 18th to 20th, inclusive, and while the seasonal rainfall is still below the normal in the northern portion of the State, the drought conditions have been entirely removed.

Frosts occurred on several occasions in northern California, but in every instance they followed immediately after rainy weather and little or no damage resulted.

Storm warnings were ordered as follows: 10th, on the California coast; 12th, from Port Harford to San Diego; 14th, Washington and Oregon coasts; 19th, from the Columbia River north; 21st and 24th, Washington and Oregon coasts. In most cases the hoists were verified.

No live-stock warnings were issued nor was there occasion for them.

The frosts in the Sacramento valley on the morning of the 4th were without warnings in the preceding morning, but were covered by warnings issued on the night of the 3d. A low area off the Washington coast on the morning of the 3d moved rapidly eastward and was followed by a high from the ocean, causing rapidly clearing weather during the afternoon. This movement was not indicated on the morning charts. Also the frost on the morning of the 13th, in the same section, was not forecast. A depression over southern Nevada moved rapidly east during the night of the 12th-13th and was followed by a slight rise in pressure along the California coast causing the weather to clear by morning with a sharp fall in temperature and heavy frost. The warning issued on the morning of the 13th for killing frosts in California was a failure because the high area off the California coast that morning moved rapidly northeastward during the day and night to the northern Plateau region, giving northeast winds and the dynamic effect prevented the expected fall in temperature in California. The frost in the Sacramento valley on the morning of the 27th was without warnings. On the evening of the 26th a depression was central in southern Nevada and cloudy and rainy weather prevailed over northern California, but by the morning of the 27th the depression had moved northeastward to Wyoming and was followed by a slight rise in pressure along the coast, causing fair weather in the Sacramento valley with light to heavy frosts. Warnings were issued in the morning for heavy frosts in northern California on the morning of the 28th, but the high area moved very rapidly eastward and by the morning of the 28th was giving northeasterly winds and slightly warmer weather where frosts had been expected.

These failures were entirely due to rapid barometric changes which were not indicated on the charts.—*G. H. Willson, District Forecaster.*